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OCTOBER 1991

RE-EXAMINATION OF TWO FORMS OF COMMON DOLPHINS (genus Delphinus) FROM THE EASTERN NORTH PACIFIC; EVIDENCE FOR TWO SPECIES

By

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William F. Perrin

ADMINISTRATIVE REPORT LJ-91-28

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Abstract

Two forms of common dolphins occur sympatrically in the Southern California Bight; a long-beaked form and a short-beaked form. We re-examined the two forms based on 318 specimens, including only full adults in morphometric analyses. Color pattern separates the two forms completely, as do total length and all measures of rostral length. Numerous additional features, such as vertebral count and tooth counts, show modal differences. The short-beaked form appears synonymous with Delphinus delphis. The long-beaked form is equivalent to the nominal species Delphinus bairdii, Dall, 1873, for which the type specimen has been lost. We propose a neotype for this species, although we note that this may represent a junior synonym. Many of the differences in color pattern between the two forms seem to hold for other ocean basins, with some variation. Other workers have also found short- and long-beaked forms in other regions. The levels of differences we see in this region of sympatry are equal to or greater than those for some other full species of small oceanic dolphins. Further work should resolve whether these differences are consistent over a wider geographic range and whether the designation of two or more full species of common dolphins is warranted. In any case, the two forms represent separate breeding populations and should be assessed and managed separately.

Introduction

Common dolphins of the genus Delphinus have a cosmopolitan distribution in tropical and temperate waters. Due to this wide distribution and because of geographical variation, there are over two dozen nominal species (Hershkovitz, 1966). Most authorities (Hershkovitz, 1966; Mitchell, 1975) consider that there is one highly variable species, Delphinus delphis Linneaus, pending further research. However, others recognize a distinct long-beaked species in some regions, such as D. capensis from South Africa (Ellerman and Morrison-Scott, 1951) and D. tropicalis from the Arabian to South China Seas (Honacki et al., 1982).

In the eastern North Pacific, Dall (1873) described the long-beaked species D. bairdii based on two female dolphins caught by Charles Scammon off Pt. Arguello, California. True (1889) stated

that he found no consistent differences between the skulls of animals from the North Atlantic and North Pacific and thus considered D. bairdii to be synonymous with D. delphis. Subsequently, G. Miller of the U.S. National Museum revaluated the material on hand and concurred with Dall (op cit.) that the Pacific specimens had significantly longer rostra than the Atlantic specimens. Miller (op cit.) also noted that the specimens from the Pacific available to True had broken rostra. Banks and Brownell (1969) were able to examine a larger series of specimens and also recognized two forms of common dolphins from the northeast Pacific based on a ratio of zygomatic width to rostrum length. They assigned the long-beaked form to Delphinus bairdii and the snort-beaked form to Delphinus delphis. Using the same rostral ratio on common dolphin specimens from other geographical regions, van Bree and Purves (1972) found a bimodal but continuous distribution of ratios and suggested that the difference was not of a species level. Neither Banks and Brownell (1969) nor van Bree and Purves (1972) stratified their sample by age and sex to evaluate the effects of ontogenetic variation and sexual dimorphism on their results. Evans (1975, 1982) described some additional differences between the two forms based on multivariate analysis of skull measurements and coloration, but did not resolve the taxonomy. In the eastern North Pacific, the common name "Baja-neritic common dolphin" has been applied to the long-beaked form and "Northern temperate offshore common dolphin" to the short-beaked form (Perrin et al., 1985).

Previous morphological studies of species of small oceanic dolphins (Delphinidae) have documented sexual dimorphism and extensive geographical variation (Perrin, 1975; 1984; Perrin et al., 1981; 1985; 1987; 1990; Schnell et al., 1986). This variation in total length, external morphology, skeletal characters, and pigmentation has made it difficult to resolve the taxonomy of these widely distributed species.

We had access to relatively large and well documented samples of the two nominal forms of Delphinus collected from a small geographical region, with nearly complete data on sex and age class. These specimens provided an unique opportunity to assess variation within and between the two forms independent of the effects of ontogenetic development, sexual dimorphism and geographical variation.

In this paper, we address the following questions: What is the nature of the morphological variation of Delphinus in this region? How distinct are the two forms; do they suggest specific or subspecific differences? Can these differences resolve the taxonomy of the genus on a world-wide basis?

Material and Methods

We included specimens that were obtained from the southern half of the Southern California Bight from 32^0 20' N to 34^0 03' N. This includes less than 300 km of coastline and the adjacent waters.

The total sample consists of 318 specimens obtained from single strandings, live captures for public display, and animals killed incidental to fishing operations. The last category includes several large samples from single schools. All of the specimens examined in this study are housed in either the Natural History Museum of Los Angeles County (LACM), the Southwest Fisheries Science Center (SWFC), or the San Diego Museum of Natural History (SDMNH). A list of specimens examined is provided in Appendix 1.

Color pattern of 128 specimens was determined from photographs or sketches. Animals observed at sea were classified directly in the field or by photographs. The specimens were classified by JEH as having the "long-beak" or "short-beak" pattern; these are markedly distinct and are described below in the results section. The assignments were made independent of other specimen data. For describing the color patterns (Fig. 1), we use the terminology of Mitchell (1970), Perrin (1972), and Evans (1975).

External measurements were taken for 214 specimens as recommended by Norris (1961), with eight additional measurements (Heyning, 1991). The measurements were collected over many years by several observers. Due to the potential variation in measuring methodologies, obvious extralimital values were deleted.

Cranial measurements and meristics were taken for 310 skulls and postcranial measurements and meristics for 126 specimens as described by Perrin (1975), with the addition of Width of rostrum at 3/4 length, Tooth width (measured transversely at midlength of the left mandibular row, at the level of top of the alveolus), Length of centrum of first lumbar vertebra, and Number of last vertebra with facet for chevron. To eliminate error due to variation in measurement methods among observers, all skull data were taken by WFP and all postcranial data by JEH. When the terminal vertebrae were missing, the number of missing vertebrae was estimated by comparison with intact series. Vertebral and sternal ribs were paired to checked for missing ribs. Thoracic vertebrae were defined as any vertebrae associated with a rib, including floating ribs. Caudal vertebrae were defined as the terminal series in the column beginning with the first vertebra articulating with a chevron bone. Counts of the manus bones (carpals, metacarpals, and phalanges) were only made on those specimens for which the manus was intact (all bones connected by cartilage) or for which flipper x-rays were available.

Only adult skulls were included in the analyses of cranial measurements. The primary criterion of adulthood was physical maturity (fusion of all vertebral epiphyses to the centra). If data on physical maturity were not available, specimens were classified as adult if they were known to be both sexually mature (in the case of females, known pregnant or lactating or at least one corpus luteum present in either ovary; in the case of males, testis weight of at least 100 g) and "cranially mature" (exhibiting fusion between the premaxillae and maxillae at the tip of the rostrum; Dailey and Perrin, 1973). The criterion of both sexual and cranial maturity is a good estimator of physical maturity for

Delphinus (Perrin and Heyning, in prep.) Only physically mature specimens were used on the analyses of postcranial measurements.

We used principal components analysis (PCA) with subsequent orthogonal rotation of factors to summarize variation in 26 cranial measurements. The analyses were performed on correlation matrices for males and females separately, using the program Factor Analysis 4M in the BMDP statistical software package (Dixon et al., 1990), with tolerance limits for matrix inversion = 0.0010, gamma = 1, and the convergence criterion for rotation = 0.00001. Missing variables were estimated with linear regression of the variable in question on the other variables, using the BMDP program Description and Estimation of Missing Data (Dixon et al., 1990), with F-to-enter limit = 4.00, missing variable limit per case = 4, eigen value lower limit = 0.001, ridge parameter = 1, method of computing covariance = allvalue, maximum number of iterations for maximum likelihood = 10, and convergence criterion for maximum likelihood = 0.01. The loading coefficients for the factor analysis are given in Table 1.

Results

The adult specimens showed clear concordance in color pattern (Fig.2), body length, and summarized cranial variation (Figs.3,4), sorting into two distinct clusters representing the long-beaked and short-beaked forms. The two series of skulls are disjunct in rostral length and sharply different in proportionate length of the rostrum (Figs.5,6).

We here describe the color pattern, external morphology and skeleton of the two forms in more detail. Specimens not entered into the analysis depicted in Figures 3 and 4 (because they were juveniles or because data on body length and skull dimensions were missing or partial) were classified as long-beaked or short-beaked based on association with other, identified specimens from the same school, or based on possession of characteristics (skull length, body length, color pattern) within the exclusive range of one or the other of the two forms.

Color Pattern

Specimens could be categorized into two distinct groups based on the following diagnoses.

Group 1, Short-beaked form (Figs.7,9): thoracic patch relatively light in color contrasting sharply with the very dark grey to black spinal field (= cape plus dorsal overlay of Perrin, 1972); flipper-to-anus stripe weakly formed or absent in most animals; flipper strip fusing with lip patch one-third to one-half of the gape length anterior to the corner of the mouth; flipper stripe narrowing significantly anterior to the eye; eye patch very dark gray or black contrasting sharply with surrounding thoracic patch; white of abdominal field extending above the flipper stripe to at least under the eye.

Group 2, Long-beaked form (Figs.8,10): thoracic patch relatively darker, not contrasting as sharply with the dark grey

spinal field as in the short-beaked form; flipper to anus stripe weakly to moderately formed; flipper stripe angling towards corner of mouth and fusing with lip patch at corner of gape to one-third anterior along gape; flipper stripe narrowing moderately anterior to eye; eye patch not contrasting strongly with surrounding thoracic patch; white of abdominal field rarely extending above flipper stripe to eye.

Specimens that were not calves (over 150 cm) were easily categorized into these two groups based on the above criteria. Although individuals may not have demonstrated every feature listed above, the overall suite of characters made identification relatively easy.

External morphology

External measurements were available for 90 sexually mature specimens. Total length was sexually dimorphic and differed significantly between the long and short-beaked forms in the study area (Tables 2,3). In both forms, males averaged 5% longer than females. In the short-beaked form, sexually mature males ranged from 172 to 201 cm, whereas sexually mature females ranged from 164 to 193 cm. In the long-beaked form, sexually mature males ranged from 202 to 235 cm, and sexually mature females from 193 to 224 cm.

Due to the size difference, most measures were larger for the long-beaked form. Some exception are noteworthy. The means for two of the head width measures (Head diameter and Rostral width at melon apex) were either equal or the short-beaked form was actually slightly wider in this dimension than the long-beaked form in both sexes (Tables 2,3). This is in spite of the facts that the long-beaked form was larger and the length measures including beak such as Tip of upper jaw to melon apex exhibited no overlap between the two forms. Thus, the head in the long-beaked form was absolutely longer but relatively narrower than in the short-beaked form.

In addition, although the samples sizes are small, while girth at eye was about equal for the two forms in both sexes, axillary girth is slightly greater for the long-beaked form; the difference increases at the level of maximum girth. Thus, the short-beaked form tended to be relatively stouter anteriorly than the long-beaked form.

Body weight data suggest that the short-beaked form was heavier for a given body length than the long-beaked form (Fig.11). Although some weights for stranded animals are biased by emaciation, we know no reason for this to be biased more so for one or the other form.

Skeletal characters

Cranium

Length of the skull was sexually dimorphic, with males of both forms having significantly larger skulls than females (Tables 4,5). The skulls of long-beaked animals were larger than those of short-beaked animals; there was no overlap in our sample. All measures

that include the length of the rostrum showed no overlap between the two forms (Length of rostrum, Tip of rostrum to external nares, Tip of rostrum to internal nares). When rostrum length vs. zygomatic width is plotted, two discreet clusters representing the two forms are represented (Figs.5,6). The mean length of the braincase differed only slightly between the two forms, and the range of long-beaked specimens fell almost entirely within the range of short-beaked specimens. The means of the rostral width measures of the two forms were almost identical, although males were still larger in this dimension than females in both forms.

The means of the cranial width measures (preorbital width, postorbital width, zygomatic width, parietal width) differed less than 5 mm between the two forms. Within sexes, the lengths of the orbits and the length of the antorbital processes were virtually identical between the two forms.

There was no overlap in the length of the upper tooth row and little overlap for the lower tooth row between the two forms. There was almost no overlap in the measures of ramus length. The teeth were also significantly wider in the long-beaked form.

The tooth counts were not sexually dimorphic. There were significantly more teeth in the long-beaked form (Table 6, Figs. 12, 13).

Postcranial characters

Sixty one specimens were physically mature and included in our analysis of postcranial morphometric data. Meristic data were analyzed for 105 specimens (Tables 7,8,9).

Total vertebral count was bimodally distributed (Fig. 14); this was due to a slightly higher number of caudal and thoracic vertebrae in the long-beaked form. Vertebral characteristics such as the positions of the first vertical foramen, last transverse process, last neural arch, last facet for a chevron, widest vertebrae, and first chevron tended to be more posteriorly located along the vertebral column in the long-beaked form. There was no difference in any meristic variables associated with the flippers.

Within each sex, the means for all measures of the postcranial skeleton were greater in the long-beaked form. The two forms overlapped in all measurements when both sexes were considered, but the overlap was slight in the height of the first lumbar vertebra, length of longest rib, manubrium width, and both measure of the scapula. In both forms, mean length of the pelvic bone was about 20 mm greater in the males than the females.

Sightings

Identification of two forms at sea based on pigmentation differences into the two groups is possible at close range (Leatherwood et al., 1988). We have never observed mixed schools of the two forms in southern California waters. One of us (JEH) has on several occasions seen distinct schools of the two forms within a few kilometers of each other on the same day. Evans (1975) also observed no mixed schools. Size of schools for both forms can range from about a dozen to several thousand individuals in the study area. No data are available regarding differences, if

any, of average school size in this region.

Discussion

Color Pattern

The color pattern of common dolphins is among the most complex of any cetacean (Mitchell, 1970) and is extremely variable. This extreme individual variation has limited the use of coloration as a taxonomic tool (True, 1889; Evans, 1975). In the eastern North Pacific, the difference between the two forms in the position of the anterior end of the flipper stripe was first described by Evans (1975). However, he did not note any other coloration differences between the two forms. He did mention that the coloration of the long-beaked nominal species from the northern Indian Ocean, D. tropicalis, was similar to that of the long-beaked form in the eastern North Pacific. The two papers Evans cited (van Bree, 1971a; Pilleri and Gihr, 1972) both lack photographs or text regarding coloration of D. tropicalis, but another paper (van Bree, 1971b) does contain an illustration of one specimen. This illustration is an oblique view of an animal with a flipper stripe that fuses with the lip patch near the posterior end of the gape, similar to the pattern found on the long-beaked form in the eastern North Pacific.

The general differences we found for long and short-beaked common dolphins off California seem to apply fairly well to common dolphins found in other ocean basins. The general pattern of the short-beaked form can be seen in animals from the North Atlantic (Leatherwood et al., 1976, Figs. 130, 133 top; Mitchell, 1970, Fig. 1) and the waters off New Zealand (Baker, 1983:112; Robson, 1976:14, 41, 45). The general pattern of the long-beaked form can be found in the North Atlantic (Mitchell, 1970, Fig. 3, listed as Delphinus sp.). Along the west coast of Africa, the animals appear to vary somewhat in pigmentation, but specimens similar to our short-beaked form (Cadenat, 1959; Figs. 9, 13, 14, 15) and other specimens more like our long-beaked form (Cadenat, 1959; Figs. 1, 4, 7) have been collected. The bairdii-type coloration pattern may apply to the long-beaked form found near the Cape of Good Hope, based on an illustration in Smithers (1983:320). This region is the locality of the type specimen of Delphinus capensis. The type specimen of D. capensis was illustrated by Gray (1828) and True (1889). However, the specimen had either lost all its coloration or the color pattern was not illustrated, making it impossible to attribute a coloration type to that specimen.

External Morphology

In the study area, the short-beaked form is significantly smaller than the long-beaked form. In the offshore waters of the eastern tropical Pacific, only the short-beaked form exists based on analysis of skull types and pigmentation (Evans 1975, 1982). In this region the short-beaked form is significantly larger than short-beaked specimens found off southern California; males average 207 cm and females 194 cm (Perrin et al., 1985). Thus, the short-

beaked form in the central tropical Pacific is intermediate in length between the short and long-beaked forms off California.

Two conclusions can be drawn from these facts. One is that although size is a useful criterion for distinguishing most adult specimens of the two forms off California, this criterion does not hold for other regions. The second point is that in the area of sympatry off California, the short-beaked form is smaller than in other regions of the eastern Pacific, perhaps due to character displacement.

Many of the modal differences that we found in external morphology probably show a greater degree of overlap than is actually present, because of inter-observer differences. These data were collected over a period of 25 years by numerous observers utilizing slightly different methodologies.

Skeletal Morphology

Our study corroborates previous works (Banks and Brownell, 1969; Evans, 1972, 1975) that indicated that there are two forms of common dolphins in the eastern North Pacific separated completely by rostral length. To take into account size differences, Banks and Brownell (1969) used a ratio of zygomatic width and rostral length to distinguish the two forms. In their response to Banks and Brownell's (op. cit.) study, van Bree and Purves (1972) noted that they found some -intermediate ratios of rostral length to zygomatic width when sampling common dolphins from most ocean basins. However, neither of these two studies separated specimens by sex, nor did they include only mature specimens. This confounded sexual dimorphism, ontogenetic variation, and geographical variation with potential subspecific or specific level differences. Evans (1982) re-plotted zygomatic width vs rostral length incorporating only sexually mature animals and got more discreet clusters than Banks and Brownell did (1969). We re plotted rostrum length by zygomatic width using only mature specimens stratified by sex and found that the differences are not just size related; they represent a true shape difference in the skulls of these two forms.

Perrin et al. (1987) found that vertebral counts were one of two diagnostic characters for distinguishing between two species of spotted dolphins in the Atlantic. We found strong modal differences in several vertebral meristics but no separation. Thus, some specimens cannot be assigned to form based on postcranial characters only.

Ecology

To occur sympatrically, these two forms must be exploiting the environment in at least subtly different ways. Banks and Brownell (1969) suggested that until the end of the 1800s, the long-beaked form was more common and that in this century the short-beaked form was more prevalent in southern California waters. These authors also suggested that the long-beaked form is more abundant in Californian waters during periods of relatively warm water. We analyzed stranding data from 1970 to 1990 for common dolphins along

southern Californian shores (Fig. 15) to evaluate any potential temporal patterns. From 1970 to 1981 inclusive, we found that 87.5% (n = 88) of the common dolphins strandings were of the shortbeaked form. During the years 1982 to 1988, 86.2% (n = 29) of the stranded common dolphins were of the long-beaked form. This began approximately with the occurrence of the warm water El Niño event of 1982/ 1983, which also apparently shifted the distribution of coastal bottlenose dolphins (Tursiops truncatus) northward along the California coast (Wells, et al., 1989). For 1989 and 1990 no clear pattern is evident, with 43% of stranded animals consisting of the long-snouted and 57% of the short-snouted form.

Banks and Brownell (1969) suggested that during periods when the long-beaked form is less abundant in southern California the short-beaked forms moves in from the north or from offshore waters. It is unlikely that the short-beaked form moves in from the north as both forms are uncommon north of Pt. Conception (see below).

Common dolphins are capable of great movements in the study area. A radio tagged female short-beaked common dolphin was sighted 270 nautical miles from its capture point after just 10 days (Evans, 1982).

The tendency of one form or the other to strand with greater frequency during different periods of years indicates that certain environmental factors may be more advantageous to one or the other form at different times. There are undoubtedly fine-scale ecological differences in how these two forms utilize southern California waters.

Distribution

The most northern record of a short-beaked common dolphin in the eastern Pacific is that of a stranded animal from British Columbia (Guiguet, 1954). Central California is the most northern limit for stranded long-beaked common dolphins (Banks and Brownell, 1969). However, at sea observations and strandings of Delphinus north of Point Conception are uncommon (Evans, 1982; Sullivan and Houck, 1979). Off southern California south of Point Conception, common dolphins are the most abundant species of cetacean (Evans, 1982), but to date, no surveys have distinguished between the long-beaked and short-beaked common dolphins.

All specimens collected in the Gulf of California and published to date represent the long-beaked form (Banks and Brownell, 1969; Evans, 1982). All animals observed at sea in the Gulf of California by JEH have been of the long-beaked form. Long-beaked specimens have been collected from coastal Peru and off Korea (Banks and Brownell, 1969).

All animals observed at sea and collected as specimens from the eastern tropical Pacific have been of the short-beaked form (Evans, 1982, Perrin et al., 1985). Specimens examined from the western North Atlantic and Black Sea regions clustered morphologically with the short-beaked form from California (Banks and Brownell, 1969).

All sightings of long-beaked animals have been within about 100 nautical miles of shore. The short-beaked form seems to range

from the coast to thousands of nm from shore. The overlap thus appears to occur in nearshore waters (Perrin et al., 1985). Because of the nearshore sympatry, the vernacular names "offshore" to describe the short-beaked form and "neritic" or "Baja neritic" for the long-beaked form are perhaps misleading. We suggest the common names "short-beaked common dolphin" and "long-beaked common dolphin" for the two forms.

Taxonomy

For all species of delphinids studied to date, moderate to strong patterns of morphological variation over sometimes short geographical distances seem to be typical (Perrin, 1984). This strong geographical variation has hampered studies regarding alpha-level taxonomy, because large samples collected over wide areas are needed to distinguish between intra-species (gamma-level taxonomy) and inter-species differences (e.g. Perrin et al., 1981, 1987).

The current study is unique in that the study area is quite small and thus free from the effects of geographical variation. Also, the samples of both forms are large enough to support statistical analysis, even when stratified by sex and age.

Based on the above evidence of complete morphological separation of these sympatrically occurring forms, we suggest that they may represent two species. We here first review the senior synonyms available for each of the two forms and then present some suggestions for further research.

The species Delphinus delphis was named by Linnaeus (1758) based on the description by Artedi (1738). Linneaus' diagnosis of corpore oblongo subtereti, rostro antenuato acuto was used to differentiate the common dolphin from Orcinus orca and Phocoena phocoena, then considered to be congeneric. No type was designated and the type locality was listed as Oceano Europaeo. The lack of a type specimen and detailed diagnosis raises several potential problems of nomenclature.

The first relatively complete description of a common dolphin from European waters is provided by Flower (1880). The specimen he described was an immature female 156 cm in length caught off the Cornwall coast of the United Kingdom in 1878. The complete skeleton was collected and housed originally in the Museum of the Royal College of Surgeons, then later transferred to the British Museum (Natural History). This animal was illustrated (Flower, op. cit.) by a watercolor of moderate quality that denotes some strong accessory stripes such as the primary and secondary abdominal stripes, and the eye-to-anus stripe of Mitchell (1970). The flipper stripe intersects with the lower jaw about one-third the distance anterior to the hind-end of the gape. By the illustrated color pattern, it is somewhat difficult to assign this specimen to one or the other of the forms we describe off California. However, the total vertebral count of 74 clearly associates the short-beaked form off California with this specimen. The tooth count of Flower's specimen was listed as 46-44/48-47. This is near the mean number of teeth we found for the short-beaked

form and just at or below the lower limit for the long-beaked form off California. We propose that this specimen be designated as the neotype for Delphinus delphis to ensure the stability of nomenclature. We tentatively refer the short-beaked form off California to this species.

The type of Delphinus bairdii was described by W. H. Dall (1873) based on two female specimens caught off Pt. Arguello, California by Capt. Charles Scammon. In the original description, Dall (op. cit.) mentioned that one entire skeleton was sent to the National Museum of Natural History. Poole and Schantz (1942) noted there are no records of the specimen arriving at the museum, nor are there any catalog numbers for it. The type specimen has not subsequently been found (J. Mead, per. comm.). What is available for the type specimens are the total lengths of the syntypes, a few skull measurements, and tooth counts published in the original description. In addition, Scammon (1874) illustrated the pigmentation of one of the syntypes, which we reproduce here (Fig. 16).

As the type specimens have been lost, it is important to firmly establish which of the two forms present off California was considered D. bairdii in order to stabilize the nomenclature. The tooth count for the type specimen was reported as 53/47 (Dall, 1873). The upper tooth count is at the upper limit of the tooth count we found for the short-beaked form and well within the range of the long-beaked form. The lower tooth count is at the minimal range of tooth counts for the long-beaked form but well within the range of the short-beaked from. However, Dall (1974) mentioned that there was room for four to five additional teeth in each mandibular tooth row. In a previous study of tooth counts in spotted dolphins (Stenella), Perrin et al. (1987) found that their tooth counts were typically higher than those listed in previous works. They believed that previous workers overlooked the anterior-most teeth because they are very small and/or buried in remnants of tissue. Thus it is possible that the tooth count of the type specimen of D. bairdii would be higher if re-examined with present methodology and within the exclusive range of the longbeaked form. Because the tooth count listed is potentially in the region of overlap between those of the two forms, it cannot be used alone to assign the type to one or the other.

The total lengths of the two females mentioned in the type description were 201 and 206 cm. These lengths fall well outside the range of total length for the short-beaked form and are very close to the average length (207.7 cm) of physically mature female long-beaked common dolphins in this region. The condylobasal length and the rostrum length of the type skull are significantly above the range of these measures for female short-beaked specimens and even above the mean condylobasal and rostrum length for the long-beaked specimens we examined. The illustration provided by Scammon (1874) depicts an animal clearly assignable to the long-beaked form based on the criteria we used in our analysis of color pattern. Therefore, based on total length, skull measures, and pigmentation, the types of D. bairdii belong to the long-beaked

form. In order to provide taxonomic stability, we propose a neotype for Delphinus bairdii. We have selected LACM 84240 as the neotype. This specimen consists of a complete skeleton of a physically mature male with accompanying external measurements, weight, and photographs.

In their analysis, Banks and Brownell (1969) found that the type specimens of D. bairdii Dall 1873, D. major Gray 1866, and D. capensis Gray 1828 were included in the cluster with the long beaked form. In their review of this study, van Bree and Purves (1972) noted that there was no reason to call the long-beaked form D. bairdii because there are no differences published between D. capensis, D. major, and D. bairdii and because D. capensis is the senior synonym. Van Bree and Purves also noted some overlap in this bivariate analysis and thus suggested that all these nominal species were indistinguishable from D. delphis. Evans (1982) found that sexually mature animals from the eastern Pacific formed two discreet clusters and the few available specimens of D. tropicalis van Bree 1971 formed another cluster with rostral lengths even greater than in the long-beaked form from the eastern Pacific.

Common dolphins are a highly variable, widely distributed group potentially consisting of two or three species. Due to the complexity of this problem, we outline several areas for further, research on this genus. First, molecular genetic (isozymes and DNA) evidence should be examined over a wide range to provide additional data sets. Morphological analysis of specimens from other regions could address both inter-specific and intra-specific variation of the nominal forms of Delphinus. Ecological and distributional studies need to be done to elucidate nonmorphological differences between the two forms.

It is clear from our analysis that these two forms of common dolphins off California exhibit species-level differences. Although the taxonomy has not yet been fully resolved, it is imperative that biologist and resource managers treat them as separate biological units.

Acknowledgements

We thank S. Smith and J. Tutak for assistance in gathering data. We thank A. Rea for access to the SDMNH collection. Pat Pinkard illustrated Figures 1 and 6. A grant from the Marine Mammal Commission assisted specimen preparation at the Natural History Museum of Los Angeles County.

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Appendix 1. List of specimens examined. Museum acronyms are as follows: LACM = Natural History Museum of Los Angeles County, SDMNH = San Diego Museum of Natural History, SWFC = Southwest Fisheries Science Center.

LACM; WFS 1029, 27088, 27090, 27099, 27100, 27401, 30860, 31491, 40127, 43471, 43474, 47147, 52320, 54065, 54066, 54067, 54068, 54070, 54071, 54073, 54074, 54075, 54179, 54180, 54454, 54461, 54463, 54558, 54565, 54568, 54618, 54619, 54621, 54622, 54625, 54626, 54627, 54628, 54629, 54631, 54632, 54633, 54634, 54635, 54636, 54640, 54641, 54642, 54643, 54644, 54732, 54735, 54736, 54738, 54741, 54743, 54744, 54745, 54746, 54747, 54748, 72181, 72278, 72279, 72280, 72281, 72282, 72283, 72284, 72285, 72286, 72287, 72288, 72289, 72293, 72299, 72333, 72334, 72335, 72336, 72337, 72338, 72339, 72340, 72341, 72342, 72343, 72344, 72345, 72346, 72347, 72348, 72349, 72350, 72351, 72352, 72353, 72354, 72355, 72356, 72357, 72358, 72359, 72360, 72361, 72362, 72363, 72364, 72365, 72366, 72367, 72368, 72369, 72370, 72371, 72372, 72373, 72374, 72375, 72376, 72377, 72378, 72379, 72380, 72381, 72382, 72383, 72384, 72385, 72386, 72387, 72388, 72389, 72390, 72391, 72392, 72393, 72394, 72395, 72396, 72397, 72398, 72399, 72400, 72401, 72402, 72403, 72404, 72405, 72406, 72407, 72408, 72409, 72410, 72411, 72412, 72413, 72414, 72415, 72416, 72417, 72418, 72419, 72420, 72421, 72422, 72423, 72424, 72425, 72426, 72427, 72428, 72429, 72430, 72454, 72468, 72469, 72494, 72495, 72496, 72497, 72498, 72499, 72500, 72501, 72502, 72503, 72505, 72543, 72544, 72587, 72593, 72595, 84007, 84009, 84021, 84038, 84039, 84040, 84041, 84042, 84045, 84046, 84050, 84054, 84067, 84071, 84074, 84077, 84078, 84083, 84090, 84091, 84092, 84094, 84096, 84100, 84105, 84106, 84108, 84109, 84118, 84121, 84125, 84127, 84129, 84130, 84131, 84132, 84134, 84135, 84136, 84137, 84138, 84139, 84140, 84143, 84155, 84163, 84170, 84171, 84172, 84173, 84177, 84178, 84181, 84183, 84184, 84185, 84196, 84197, 84199, 84207, 84208, 84209, 84216, 84220, 84221, 84223, 84225, 84226, 84227, 84228, 84229, 84230, 84231, 84232, 84233, 84236, 84239, 84240, 84241, 84254, 84255, 84256, 84257, 84258, 84261, 84278, 84279, 84280, 84281, 84282, 84283, **:SDMNH;** 961, 2591, 19144, 19145, 20140, 20141, 20142, 21204, 21205 21206, 21207, 21208, 21209, 21210, 21211, 21266, 21269, 22841 22865, 23017, 23018, 23024, 23582, 23741, 23743, 23744, 23745, 23810, **:SWFC;** 39, 40, 43, 44, 45, 48

Table 1. Orthogonally rotated factor loadings for first two factors for male and female cranial variation for common dolphins from southern California with variance explained by factor (VAR).

Measurement	Males		Females	
	Fact. I	Fact. II	Fact. I	Fact. II
Condlyobasal length	0.952	0.143	0.957	0.088
Len. rostrum	0.963	0.121	0.970	0.004
Wid. rostrum at base	0.046	0.328	-0.159	0.478
at 1/4 len.	0.040	0.046	0.004	0.672
at 1/2 len.	-0.013	0.089	-0.020	0.859
at 3/4 len.	0.030	0.154	0.087	0.764
Wid. PMX at 1/2 length.	0.150	0.273	0.232	0.546
Tip rostrum to ext. nares	0.952	0.123	0.973	0.020
Tip rostrum to int. nares	0.954	0.125	0.968	0.043
Preorbital width	0.082	0.800	-0.039	0.749
Postorbital width	0.289	0.726	0.130	0.697
Zygomatic width	0.402	0.652	0.213	0.640
Width external nares	0.177	0.456	0.188	-0.062
Greatest width of PMXs	-0.017	0.790	0.066	0.239
Parietal width	0.308	0.295	0.300	0.219
Height of braincase	0.316	0.169	0.338	0.089
Length of braincase	0.363	0.240	0.526	0.416

Table 1. (continued)

Length Temporal fossa	0.461	0.035	0.334	0.145
Height temporal fossa	0.559	0.020	0.402	0.069
Length of orbit	0.072	-0.112	0.212	0.236
Length antorbital proc.	0.151	0.686	0.228	0.564
Width of internal nares	0.366	0.312	0.287	0.293
Length upper toothrow	0.952	0.101	0.968	10.008
Length lower toothrow	0.939	0.152	0.944	0.075
Length ramus	0.942	0.131	0.947	0.094
Height Ramus	0.770	0.327	0.755	0.267
VAR	8.243	3.619	8.160	4.628

Table 2. Means, standard deviations (for sample sizes > 24), sample size (in parentheses), and minimum and maximum values for external measures for adult male specimens of the two forms of common dolphins from California. Snout measures are taken from the tip of the upper jaw.

	Short-beaked	Long-beaked
Total length	189.5 ± 7.37 (28) 172 - 201	219.1 (15) 202 - 235
Snout to anus	137.7 (20) 127 - 148	158.3 (12) 148 - 174
Snout to genital slit	121.0 (23) 109 - 128	138.8 (12) 129 - 151
Snout to umbilicus	89.3 (18) 83 - 95	103.1 (10) 100 - 109
Snout to dorsal fin tip	114.4 (18) 105 - 126	125.5 (12) 119 - 137
Snout to ant. dorsal fin	84.7 (7) 80 - 91	95.3 (12) 88 - 100
Snout to flipper	44.6 (17) 41 - 49	49.3 (10) 47 - 52
Snout to ear	35.9 (15) 32.5 - 40.0	38.6 (9) 37.0 -41
Snout to eye	30.8 (20) 27.3 - 34.3	34.4 (12) 31.0 -38.0
Snout to gape	26.1 (24) 21.7 - 28.0	29.1 (12) 27.0 -32.0
Snout to blowhole	31.4 (19) 27.7 - 34.2	34.8 (13) 31.1 -40.0
Snout to melon apex	12.3 ± 0.89 (25) 10.5 - 14.0	15.7 (14) 14.0 -17.5
Eye to ear	5.3 (20) 3.3 - 8.0	5.6 (9) 5.0 - 6.5
Eye to gape	5.8 (20) 4.6 - 6.6	6.4 (12) 5.5 - 7.0
Right eye to blowhole	18.25	17.4

	(2) 18.0 - 18.5	(7) 16.0 - 18.5
Left eye to blowhole	14.29 (15) 10.7 - 18.0	16.2 (9) 15.0 - 17.5
Blowhole length	1.2 (11) 0.9 - 1.5	1.3 (12) 1.0 - 2.0
Blowhole width	2.4 (13) 1.6 - 3.0	2.5 (12) 2.0 - 3.0
Head diameter at eyes	20.1 (12) 19.0 - 21.1	20.1 (11) 19.0 - 22.5
Rostral width at melon apex	7.4 (11) 6.1 - 8.4	7.2 (13) 6.2 - 8.0
Projection lower jaw	0.4 (11) 0.2 - 0.5	0.7 (11) 0.3 - 1.5
Flipper length, anterior	30.0 (22) 25.4 - 34.3	31.1 (12) 28.9 - 33.0
Flipper length, posterior	21.2 (22) 17.2 - 24.6	22.7 (12) 18.9 - 25.0
Flipper width	9.9 (21) 8.5 - 11.3	10.2 (12) 8.8 - 12.2
Length genital slit	9.6 (11) 5.9 - 12.3	9.3 (11) 6.6 - 12.5
Fluke width	42.9 (22) 29.9 - 52.3	47.9 (11) 40.0 - 58.0
Fluke depth at lobe	12.5 1	14.7 (7) 13.3 - 16.5
Fluke depth at notch	12.0 (21) 9.9 - 14.0	13.0 (10) 12.0 - 14.5
Fluke notch depth	2.4 (18) 1.8 - 3.5	2.4 (11) 1.5 - 3.0
Dorsal fin height	20.1 (22) 17.0 - 26.1	19.9 (12) 17.0 - 24.5
Dorsal fin base length	30.1 (8) 24.9 - 33.0	32.7 (10) 30.0 - 36.0
Girth at eye	70.5 (2) 68 - 73	68.6 (8) 66 - 73

Girth at axilla	97.5 (23) 88 - 111	100.1 (10) 87 - 110
Girth maximum	101.4 (7) 96 - 108	112.4 (10) 93 - 133
Girth at anus	63.1 (21) 49 - 73	66.9 (11) 54 - 80
Girth midway anus-fluke notch	32.5 (2) 32 - 33	34.8 (8) 31 - 38
Caudal height	15.0 (2) 15.0	15.6 (8) 14 - 17
Caudal thickness	3.5 (2) 3.0 - 4.0	4.9 (8) 4.0 - 6.0

Table 3. Means, standard deviations (for sample sizes >24), sample size (in parentheses), and minimum and maximum values for external measures for adult female specimens of the two forms of common dolphins from California. Snout measures are taken from the tip of the upper jaw.

	Short-beaked	Long-beaked
Total length	180.1 ± 6.5 (37) 164 - 193	207.7 (10) 193 - 224
Snout to anus	130.3 ± 4.3 (27) 120 - 138	145.0 (6) 139 - 151
Snout to genital slit	123.7 ± 4.4 (26) 116 - 133	138.0 (6) 132 - 145
Snout to umbilicus	86.3 (24) 80 - 90	95.5 (4) 94 - 98
Snout to dorsal fin tip	106.9 ± 4.0 (27) 98 - 115	122.9 (7) 113 - 133
Snout to ant. dorsal fin	82.6 (18) 76 - 86	94.3 (7) 88 - 101
Snout to flipper	41.9 ± 2.1 (28) 38 - 46	47.5 (6) 45 - 50
Snout to ear	34.2 (22) 31.5 - 37.2	38.9 (7) 36.5 - 43.0
Snout to eye	29.3 ± 1.6 (33) 26.5 - 32.7	33.6 (7) 31.0 - 37.0
Snout to gape	24.8 ± 1.3 (33) 22.0 - 27.5	28.4 (7) 27.0 - 31.0
Snout to blowhole	30.4 ± 1.8 (34) 26.4 - 33.8	34.7 (8) 32.5 - 38.4
Snout to melon apex	11.6 ± 0.7 (26) 10.5 - 13.0	15.4 (8) 13.3 - 17.0
Eye to ear	5.2 (21) 4.6 - 6.2	5.6 (6) 5.0 - 6.1
Eye to gape	5.8 ± 0.4 (25) 4.7 - 7.0	5.8 (7) 4.5 - 6.9

Right eye to blowhole	17.1 (10) 16.3 - 18.5	16.3 (5) 16.0 - 16.5
Left eye to blowhole	14.6 (19) 13.2 - 16.0	15.0 (7) 14.0 - 16.0
Blowhole length	1.1 (21) 0.8 - 1.5	1.1 (8) 0.8 - 1.3
Blowhole width	2.1 (21) 1.7 - 2.9	2.4 (8) 1.9 - 2.8
Head diameter at eyes	19.9 ± 1.5 (26) 17.2 22.8	18.9 (7) 18.0 - 19.5
Rostral width at melon apex	7.9 (19) 6.0 - 11.0	6.5 (8) 6.0 - 7.4
Projection lower jaw	0.4 (16) 0.2 - 1.0	0.6 (4) 0.5 - 1.0
Flipper length, anterior	27.1 ± 2.1 (27) 24.0 - 31.0	29.7 (8) 28.4 - 32.0
Flipper length, posterior	19.5 ± 1.8 (27) 16.2 - 23.0	20.4 (8) 18.0 - 23.0
Flipper width	8.8 ± 0.8 (25) 7.1 - 11.0	9.7 (8) 9.0 - 10.7
Length genital slit	12.1 (11) 9.5 - 16.6	11.5 (8) 8.0 - 13.0
Fluke width	38.5 ± 3.9 (25) 29.0 - 46.0	42.4 (7) 38.0 - 49
Fluke depth at lobe	12.3 (4) 11.5 - 13.0	13.1 (4) 12.0 - 14.0
Fluke depth at notch	11.4 (24) 9.6 - 13.0	11.7 (7) 10.5 - 13.0
Fluke notch depth	2.3 ± 0.6 (25) 1.0 - 3.0	2.5 (7) 1.5 - 3.0
Dorsal fin height	16.6 ± 1.4 (25) 14.0 - 19.0	17.4 (8) 13.0 - 21.1
Dorsal fin base length	27.1 (10) 19.0 - 32.0	33.0 (8) 27.0 - 41.1
Girth at eye	67.8	67.7

	(6) 66 - 71	(6) 65 - 70
Girth at axilla	91.7 ± 6.1 (26) 73 - 101	95.4 (8) 83 - 103
Girth maximum	99.2 (15) 86 - 111	106.6 (7) 87 - 116
Girth at anus	54.5 ± 4.5 (26) 47 - 66	55.9 (7) 50 - 65
Girth midway anus-fluke notch	29.6 (5) 28 - 32	31.0 (4) 29 - 34
Caudal height	13.6 (5) 13 - 14	15.8 (4) 14 - 19
Caudal thickness	3.75 (4) 3 - 5	4.4 (5) 3 - 6

Table 4. Means, standard deviations (for sample sizes >30), sample sizes (in parentheses) and minimum and maximum values for skull measurements for adult male specimens of the two forms of common dolphins from the coast of southern California.

	Short-beaked	Long-beaked
Condylobasal length	421.5 ± 13.04 (48) 392-445	473.6 (19) 446-498
Length of rostrum	254.4 ± 10.97 (48) 227-275	302.0 (19) 286-321
Width of rostrum:		
At base	86.9 ± 4.03 (50) 78-98	85.9 (19) 77-93
At 1/4 length	57.6 ± 2.87 (48) 52-63	57.4 (19) 53-61
At 1/2 length	51.3 ± 2.55 (48) 45-57	50.9 (19) 46-55
At 3/4 length	38.1 ± 2.65 (48) 33-44	38.0 (19) 33-47
Width of PMXs at 1/2 length	23.6 ± 1.67 (48) 21-27	23.9 (19) 19-28
Tip of rostrum to:		
External nares	301.9 ± 11.91 (48) 272-321	359.5 (19) 331-375
Internal nares	297.1 ± 11.53 (47) 270-318	344.5 (19) 323-370
Preorbital width	167.3 ± 4.76 (50) 158-177	167.4 (19) 156-181
Postorbital width	187.6 ± 4.81 (49) 176-197	190.4 (19) 183-205
Zygomatic width	184.9 ± 5.27 (49) 173-195	189.1 (19) 181-204
Width of external nares	45.1 ± 2.26 (50) 39-50	45.6 (19) 41-49
Greatest width of PMXs	71.5 ± 2.99 (50) 66-78	71.1 (19) 66-77

Parietal width	148.9 ± 2.99 (50) 139-162	153.8 (19) 145-162
Height of braincase	108.0 ± 4.35 (50) 98-116	112.3 (19) 106-126
Length of braincase	116.1 ± 4.73 (49) 106-124	119.3 (18) 114-129
Length of temporal fossa	67.6 ± 4.19 (50) 59-84	73.6 (19) 65-81
Height of temporal fossa	51.0 ± 4.11 (50) 41-60	57.6 (19) 49-63
Length of orbit	49.3 ± 1.99 (50) 45-54	49.2 (19) 44-55
Length of antorb. process	44.5 ± 2.62 (50) 39-51	44.9 (19) 41-50
Width of internal nares	54.2 ± 2.15 (49) 48-59	55.8 (19) 53-60
Length of upper toothrow	214.3 ± 9.90 (47) 188-232	258.8 (19) 241-275
Length of lower toothrow	208.5 ± 10.77 (49) 184-232	246.4 (20) 228-268
Length of ramus	354.8 ± 13.34 (49) 323-379	405.0 (20) 384-433
Height of ramus	64.1 ± 2.52 (50) 57-70	70.8 (20) 66-77
Tooth width	2.81 ± 0.233 (41) 2.5-3.4	3.71 (15) 3.3-4.0

Table 5. Means, standard deviations (for sample sizes >30), sample sizes (in parentheses) and minimum and maximum values for skull measurements for adult female specimens of the short-beaked and long-beaked forms of common dolphins from the coast of southern California.

	Short-beaked	Long-beaked
Condylobasal length	406.3 ± 14.06 (49) 382-442	465.5 (12) 445-486
Length of rostrum	244.0 ± 10.99 (49) 218-264	296.2 (12) 281-314
Width of rostrum:		
At base	84.9 ± 4.10 (51) 73-93	82.7 (13) 78-88
At 1/4 length	55.7 ± 2.59 (49) 49-63	55.3 (12) 52-58
At 1/2 length	48.7 ± 2.06 (49) 43-55	48.3 (12) 46-51
At 3/4 length	35.4 ± 2.12 (49) 32-41	35.1 (12) 30-39
Width of PMXs at 1/2 length	22.7 ± 1.49 (49) 20-25	23.5 (12) 21-26
Tip of rostrum to:		
External nares	290.3 ± 12.18 (48) 263-314	343.2 (12) 326-364
Internal nares	285.3 ± 12.64 (49) 258-316	339.5 (12) 322-355
Preorbital width	161.6 ± 5.06 (51) 150-175	160.3 (13) 150-169
Postorbital width	182.5 ± 4.81 (51) 174-192	183.1 (13) 173-193
Zygomatic width	179.6 ± 4.91 (51) 170-190	180.8 (13) 173-191
Width of external nares	44.3 ± 2.35 (50) 39-50	45.1 (13) 43-50

Maximum width of PMXs	71.8 ± 3.19 (50) 63-79	70.8 (13) 68-74
Parietal width	145.4 ± 5.26 (51) 132-156	149.8 (13) 138-158
Height of braincase	103.5 ± 15.89 (50) 94-114	108.8 (13) 100-118
Length of braincase	112.0 ± 4.32 (49) 104-124	116.8 (13) 111-124
Length of temporal fossa	65.8 ± 4.15 (51) 54-73	69.4 (13) 64-76
Height of temporal fossa	48.9 ± 3.78 (51) 42-58	55.5 (13) 48-68
Length of orbit	48.7 ± 2.22 (51) 45-53	48.2 (13) 44-53
Length of antorb. process	42.4 ± 2.52 (51) 36-48	43.8 (13) 38-47
Width of internal nares	52.1 ± 2.16 (51) 47-57	54.1 (13) 50-60
Length of upper toothrow	205.0 ± 10.09 (49) 181-226	253.6 (12) 232-271
Length of lower toothrow	200.5 ± 9.84 (50) 181-218	238.3 (13) 215-255
Length of ramus	343.0 ± 12.69 (50) 321-372	394.3 (13) 371-419
Height of ramus	62.2 ± 2.89 (50) 57-69	67.8 (13) 65-71
Tooth width	2.83 ± 0.238 (33) 2.3-3.3	3.57 (11) 3.2-4.0

Table 6. Medians, sample size (in parentheses), and minimum and maximum values for tooth row counts for the two forms of common dolphins from the coast of southern California.

	Short-beaked	Long-beaked
Upper teeth, left	49 (136) 42 - 54	53 (45) 48 - 59
Upper teeth, right	49 (138) 42 - 54	53 (45) 47 - 58
Lower teeth, left	47 (143) 41 - 53	51 (46) 47 - 55
Lower teeth, right	47 (172) 41 - 53	51 (47) 47 - 55

Table 7. Medians, standard deviations (for sample sizes >24), sample size (in parentheses), and minimum and maximum values for postcranial meristics for the two forms of common dolphins from southern California.

	Short-beaked	Long-beaked
Vertebral Count	76 ± 1.48 (80) 74 - 80	78 ± 0.64 (25) 77 - 80
No. of lumbar vert	20 ± 1.12 (76) 18 - 24	20 ± 0.96 (25) 19 - 22
No. of caudal vert.	34 ± 1.30 (75) 30 - 36	35 ± 1.04 (25) 33 - 37
First vert with vertical foramina	54 ± 1.70 (76) 49 - 59	55 ± 1.46 (26) 53 - 57
Last vert with transverse process	58 ± 1.26 (75) 54 - 61	59 ± 1.22 (26) 55 - 60
Last vert with neural arch	63 ± 1.45 (75) 60 - 68	65 ± 1.03 (25) 63 - 67
First vert with chevron	43 ± 1.19 (75) 41 - 46	44 ± 0.83 (25) 42 - 45
No. of chevrons	25 ± 2.32 (71) 18 - 29	27 ± 1.78 (25) 23 - 30
No. of vertebral ribs	15 ± 0.63 (78) 13 - 16	15 ± 056 (25) 14 - 16
No. of sternal ribs	8 ± 0.76 (77) 6 - 10	8 ± 0.72 (26) 7 - 9
Number of carpals and metacarpals	10 (33) 10	10 (15) 10
Phalanges, digit 1	2 (33) 1 - 2	2 (10) 1 - 3
Digit 2	8 ± 0.62 (32) 7 - 9	8 (9) 8 - 9
Digit 3	6 ± 0.45 (33) 5 - 7	6 (9) 6 - 7

Digit 4	2 ± 0.5 (31) 1 - 3	2 (10) 1 - 3
Digit 5	1 (29) 1	1 (9) 1
Number of cervicals fused	2 + 0.42 (75) 2 - 4	2 (25) 2
Last vert with facet for chevron	66 + 1.56 (65) 61 - 70	68 (24) 59 - 70
Widest vertebrae	23 + 1.42 (70) 21 - 26	24 + 1.46 (25) 22 - 27

Table 8. Means, standard deviations (for sample sizes > 24), sample size (in parentheses), and minimum and maximum values for postcranial measures for adult male specimens of the two forms of common dolphins from California.

	Short-beaked	Long-beaked
Width of atlas	126.5 ± 8.1 (26) 110 - 143	133.3 (6) 125 -142
Height of atlas	51.7 ± 2.7 (26) 46 - 58	54.5 (6) 53 - 56
Length of atlas lateral process	24.7 + 2.4 (26) 19 - 30	27.8 (6) 27 - 30
Length of atlas dorsal spine	45.6 + 4.7 (26) 35 - 56	50.2 (6) 46 - 54
Height of 1st thoracic vert.	47.5 (11) 42 - 52	51.0 (4) 50 - 52
Width of 1st thoracic vert.	88.0 + 5.8 (26) 77 - 100	90.3 (6) 85 - 95
Length of 1st thoracic spine	33.2 (23) 23 - 41	39.0 (6) 34 - 45
Height of 1st lumbar vert.	51.0 (23) 48 - 56	57.4 (5) 55 - 59
Width of 1st lumbar vert.	191.6 + 9.0 (25) 177 - 208	204.5 (6) 192 - 211
Length of 1st lumbar spine	74.2 (24) 66 - 84	80.2 (6) 75 - 84
Length of 1st vert. rib1	21.5 + 6.0 (25) 112 - 131	132.0 (6) 121 - 142
Length of longest vert. rib	269.6 (24) 249 - 287	298.8 (6) 287 - 322
Max. width of manubrium	102.2 + 5.7 (26) 91 - 112	114.8 (5) 105 - 121

Height of scapula	126.1 ± 6.1 (25) 117 - 139	139.0 (5) 136 - 144
Length of scapula	122.0 ± 6.6 (25) 112 - 132	135.0 (5) 133 - 137
Maximum length of humerus	56.6 (24) 50 - 62	62.0 (5) 57 - 65
Maximum lenght of radius	76.7 (23) 70 - 84	83.8 (5) 81 - 88
Maximum length of ulna	66.6 (23) 59 - 73	73.6 (5) 70 -78
Maximum width of hemerus	40.4 (24) 37 - 43	42.8 (5) 41-44
Length of longest chevron	46.3 ± 4.1 (26) 37 - 53	51.3 (6) 48 - 59
Length of longest pelvic	92.7 (20) 64 - 111	93.4 (5) 79 - 101
Width of widest vertebrae	193.9 ± 9.6 (25) 174 - 214	207.4 (5) 200 - 211
Length of centrum of 1st lumbar	23.5 ± 1.8 (26) 20 - 27	25.5 (4) 23 - 30

Table 9. Means, standard deviations (for sample sizes > 24), sample size (in parentheses), and minimum and maximum values for postcranial measures for adult female specimens of the two forms of common dolphins from California.

	Short-beaked	Long-beaked
Width of atlas	120.0 ± 5.6 (25) 108 - 129	127.4 (5) 121 - 135
Height of atlas	48.1 (24) 42 - 52	53.8 (5) 50 - 58
Length of atlas lateral process	23.4 (24) 20 - 28	25.4 (5) 24 - 28
Length of atlas dorsal spine	44.5 ± 4.2 (25) 38 - 55	50.2 (5) 47 - 54
Height of 1st thoracic vert.	45.1 (13) 41 - 49	51.0 (2) 47 - 55
Width of 1st thoracic vert.	82.6 (23) 74 - 94	88.6 (5) 79 - 99
Length of 1st thoracic spine	28.7 (23) 20 - 48	30.8 (5) 21 - 35
Height of 1st lumbar vert.	48.3 (23) 41 - 53	54.2 (5) 50 - 58
Width of 1st lumbar vert.	184.3 (24) 165 - 200	200.2 (5) 187 - 216
Length of 1st lumbar spine	68.4 (24) 56 - 78	75.8 (5) 71 - 82
Length of 1st vert. rib	112.2 ± 4.1 (25) 105 - 121	121.0 (4) 115 - 130
Length of longest vert. rib	256.2 ± 9.0 (25) 241 - 278	275.5 (4) 268 - 285
Max. width of manubrium	96.6 ± 4.6 (25) 87 - 109	108.0 (4) 99 - 122
Height of scapula	118.2 ± 6.8 (25) 104 - 130	128.5 (4) 118 - 143

Length of scapula	112.6 ± 6.5 (25) 101 - 123	119.0 (4) 110 - 129
Max. length of humerus	52.9 ± 3.3 (25) 47 - 61	58.3 (4) 57 - 60
Maximum length of radius	70.6 ± 5.0 (25) 63 - 82	76.8 (4) 65 - 86
Maximum length of ulna	61.4 ± 5.1 (25) 54 - 73	70.0 (4) 68 - 72
Maximum width of humerus	36.8 (24) 33 - 40	41.5 (4) 38 - 46
Length of longest chevron	41.8 ± 3.8 (25) 34 - 50	48.0 (5) 41 - 54
Length of longest pelvic	62.9 (17) 47 - 76	73.8 (5) 58 - 84
Width of widest vertebrae	187.3 (23) 169 - 205	202.8 (5) 187 - 220
Length of centrum of 1st lumbar	21.8 (23) 20 - 24	24.2 (5) 22 - 27

Figures

Fig. 1. Color pattern terminology for common dolphins as used in text. Abbreviations are: AF, abdominal field; EP, eye patch; FAS, flipper-to-anus stripe; FP, flank patch; FS, flipper stripe; LP, lip patch; SF, spinal field; TP, thoracic patch.

Fig. 2. General color pattern for short-beaked (top) and longbeaked (bottom) common dolphins from southern California.

Fig. 3. Scatter plot of Principal Components Axis 1 of skull measurements vs. body length for male common dolphins. Markers indicate color pattern: Triangles represent the short-beaked pattern; solid circles the long-beaked pattern; and open circles no available pattern.

Fig. 4. Scatter plot of Principal Components Axis 1 of skull measurements vs. body length for female common dolphins. Markers indicate color pattern: Triangles represent the short-beaked pattern; solid circles the long-beaked pattern; and open circles no available pattern.

Fig. 5. Zygomatic width vs. length of rostrum for adult male common dolphins from southern California.

Fig. 6. Zygomatic width vs. length of rostrum for adult females common dolphins from southern California. The type of D. bairdii is included based on measurements from the literature.

Fig. 7. Representative color patterns for adult short-beaked common dolphins from southern California to indicate individual variation.

Fig. 8. Representative color patterns of long-beaked common dolphins from southern California to indicate individual variation. Top specimen is the neotype of D. bairdii.

Fig. 9. Detail of typical short-beaked color pattern. Note position of flipper stripe and where it fuses with lip patch.

Fig. 10. Detail of typical long-beaked color pattern. Note the position of the flipper stripe in contrast with the short-beaked form in Fig. 9.

Fig. 11. Plot of length and weight data for the two forms off California. Note that for the same body length, the short-beaked form tends to be heavier.

Fig. 12. Upper left toothrow counts for common dolphins from southern California.

Fig. 13. Lower left toothrow counts for common dolphins from southern California.

Fig. 14. Total vertebral counts for common dolphins from southern California.

Fig. 15. Strandings by year of common dolphins classified to form from southern California. The differences of absolute abundance of strandings reflects, in part, differences in responding effort to strandings.

Fig. 16. Illustration from Scammon (1874) of one of the syntypes of D. bairdii.

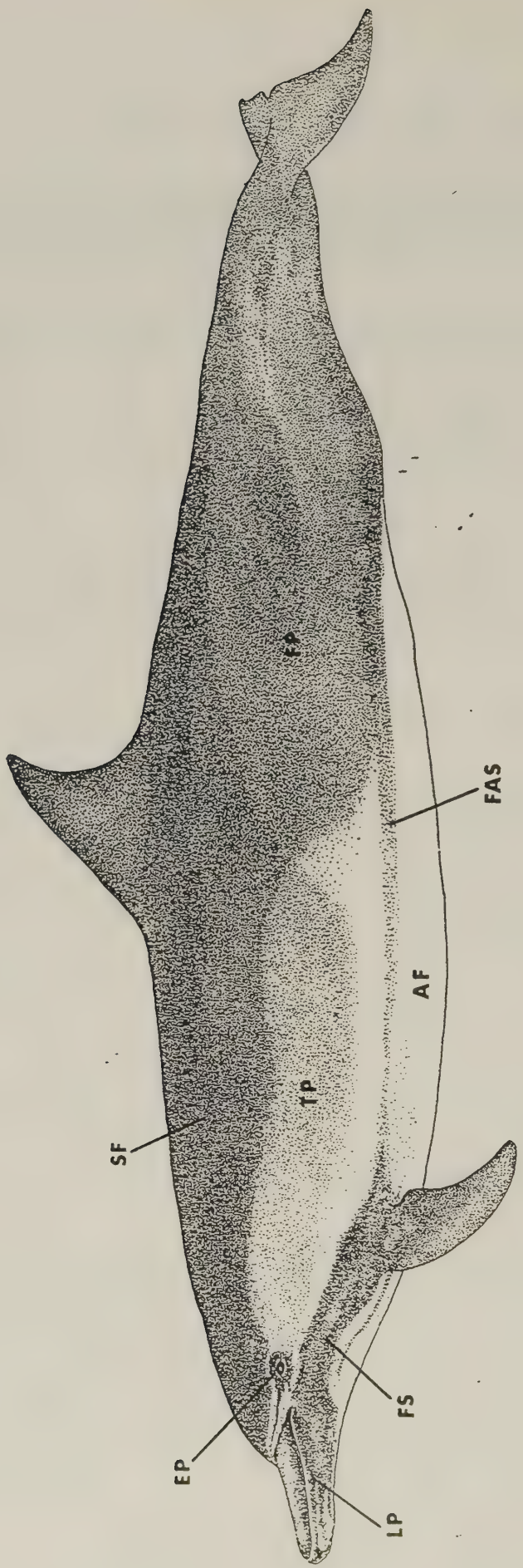


Figure 1

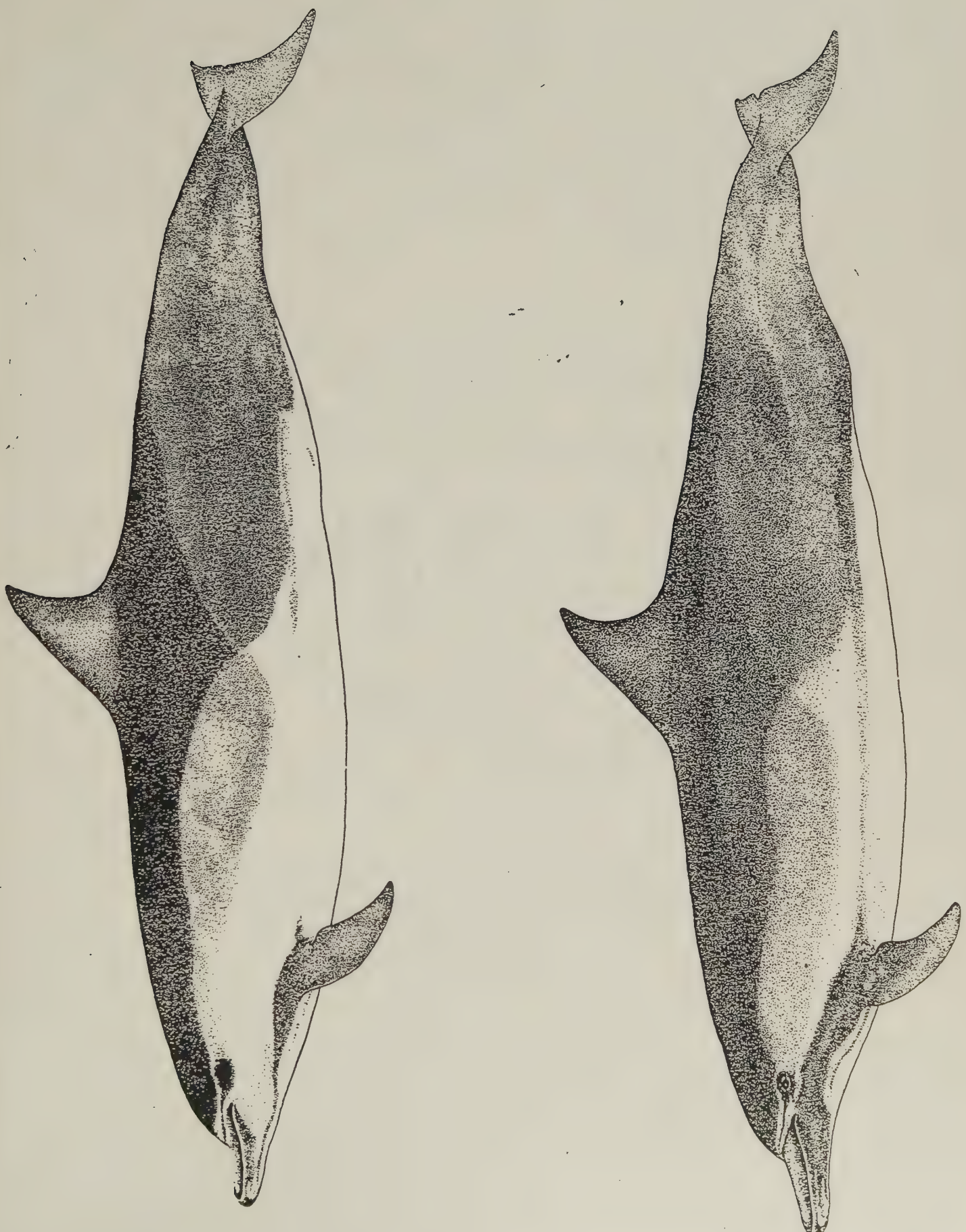
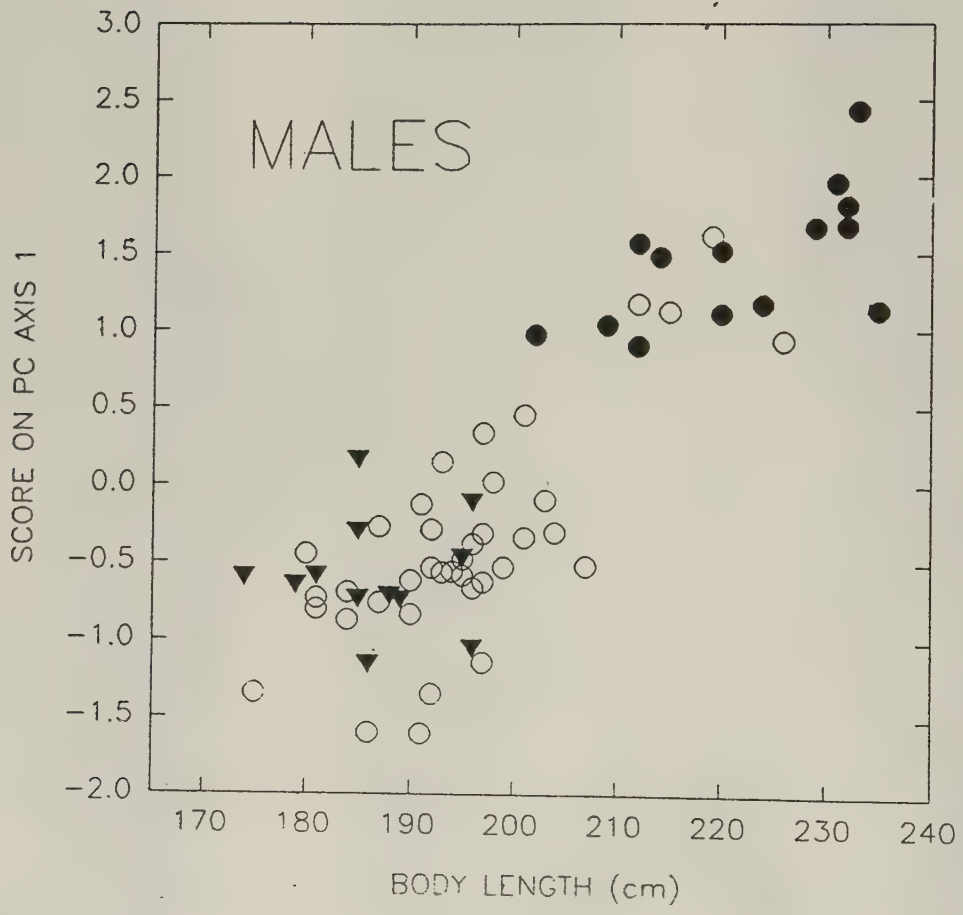


Figure 2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2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
170
180
190
200
210
220
230
240
BODY LENGTH (cm)

Figure 3

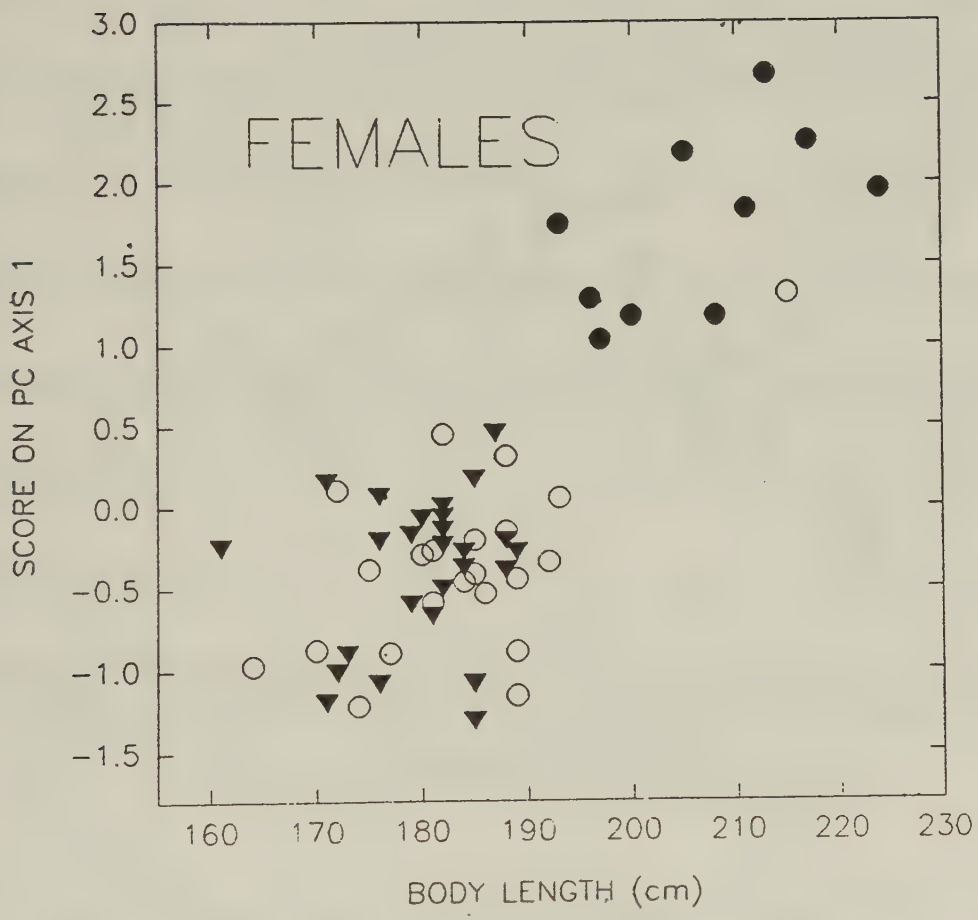

FEMALES
SCORE ON PC AXIS 1
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
160
170
180
190
200
210
220
230
BODY LENGTH (cm)

Figure 4

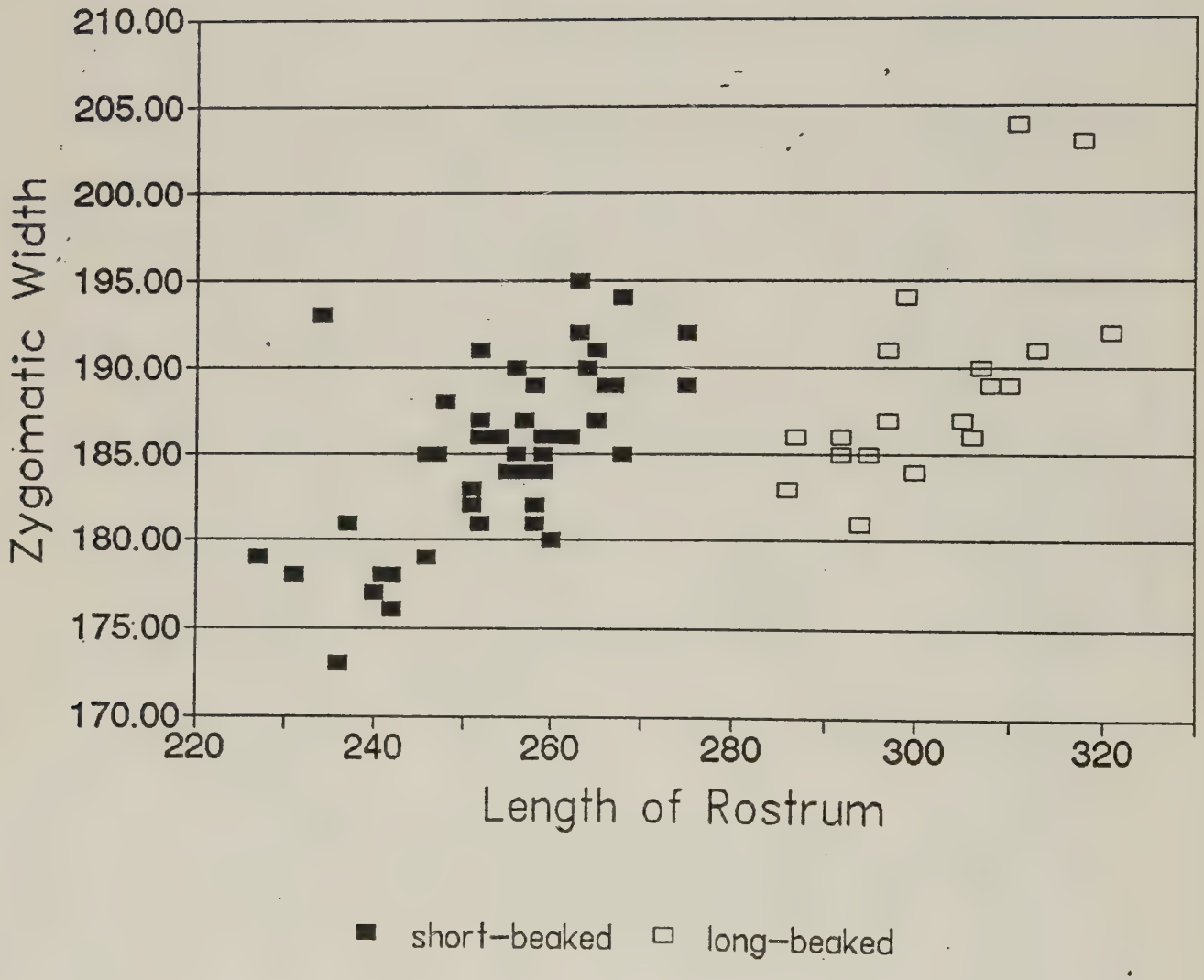

210.00
205.00
200.00
195.00
190.00
185.00
180.00
175.00
170.00
Zygomatic Width
220
240
260
280
300
320
Length of Rostrum
short-beaked
long-beaked

Figure 5

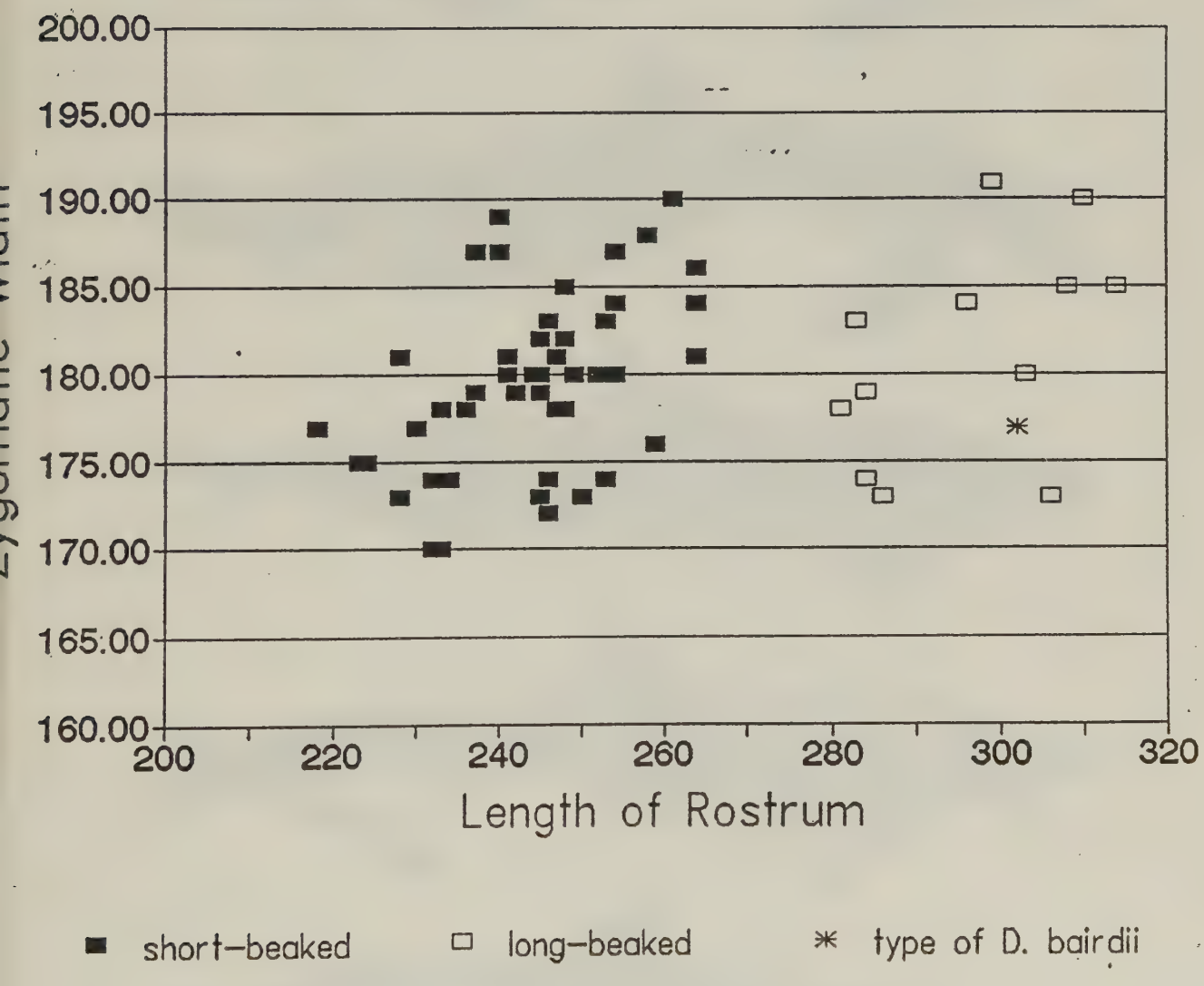

200.00
195.00
190.00
185.00
180.00
175.00
170.00
165.00
160.00
200
220
240
260
280
300
320
Length of Rostrum
short-beaked
long-beaked
type of D. bairdii

Figure 6

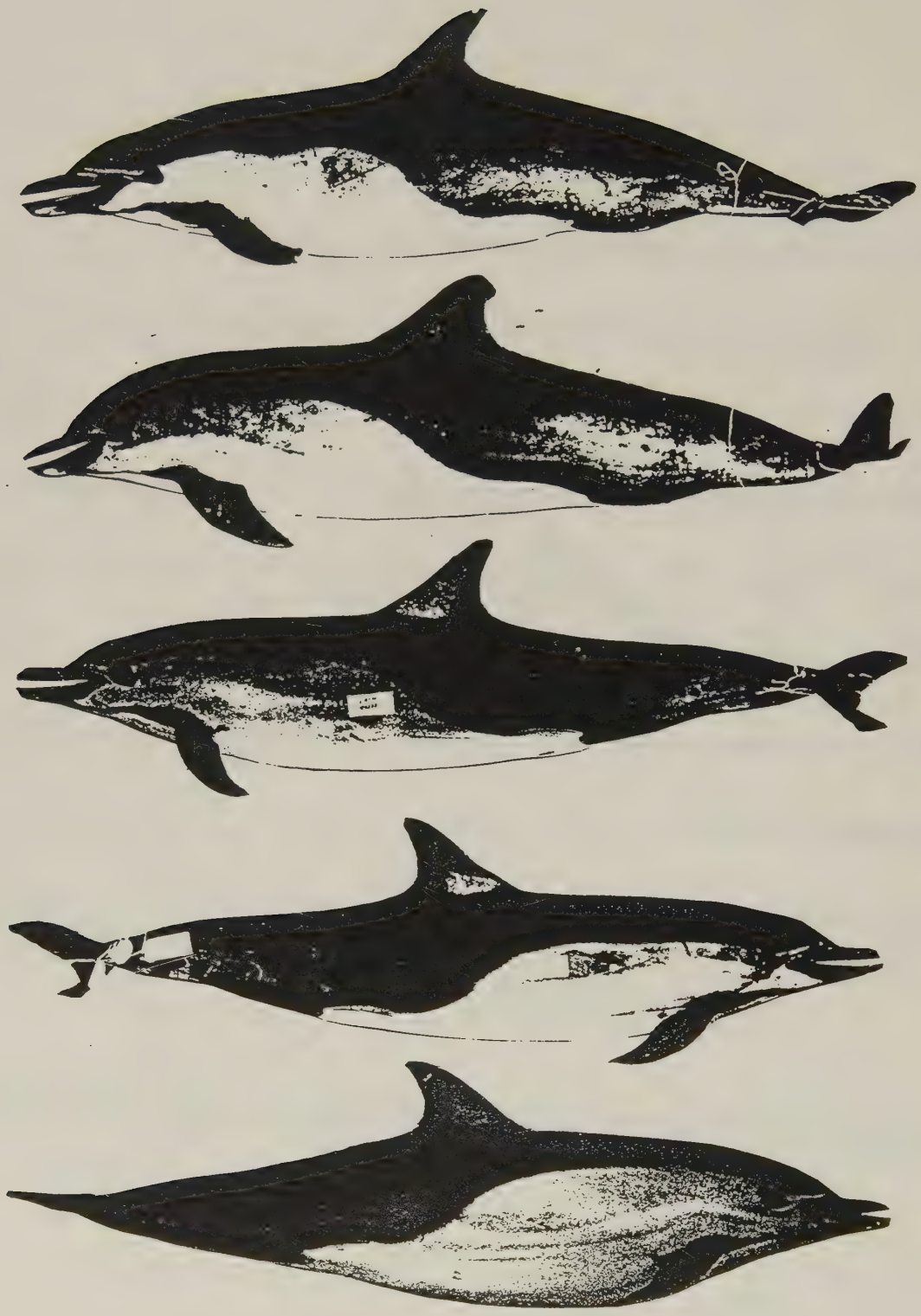


Figure 7

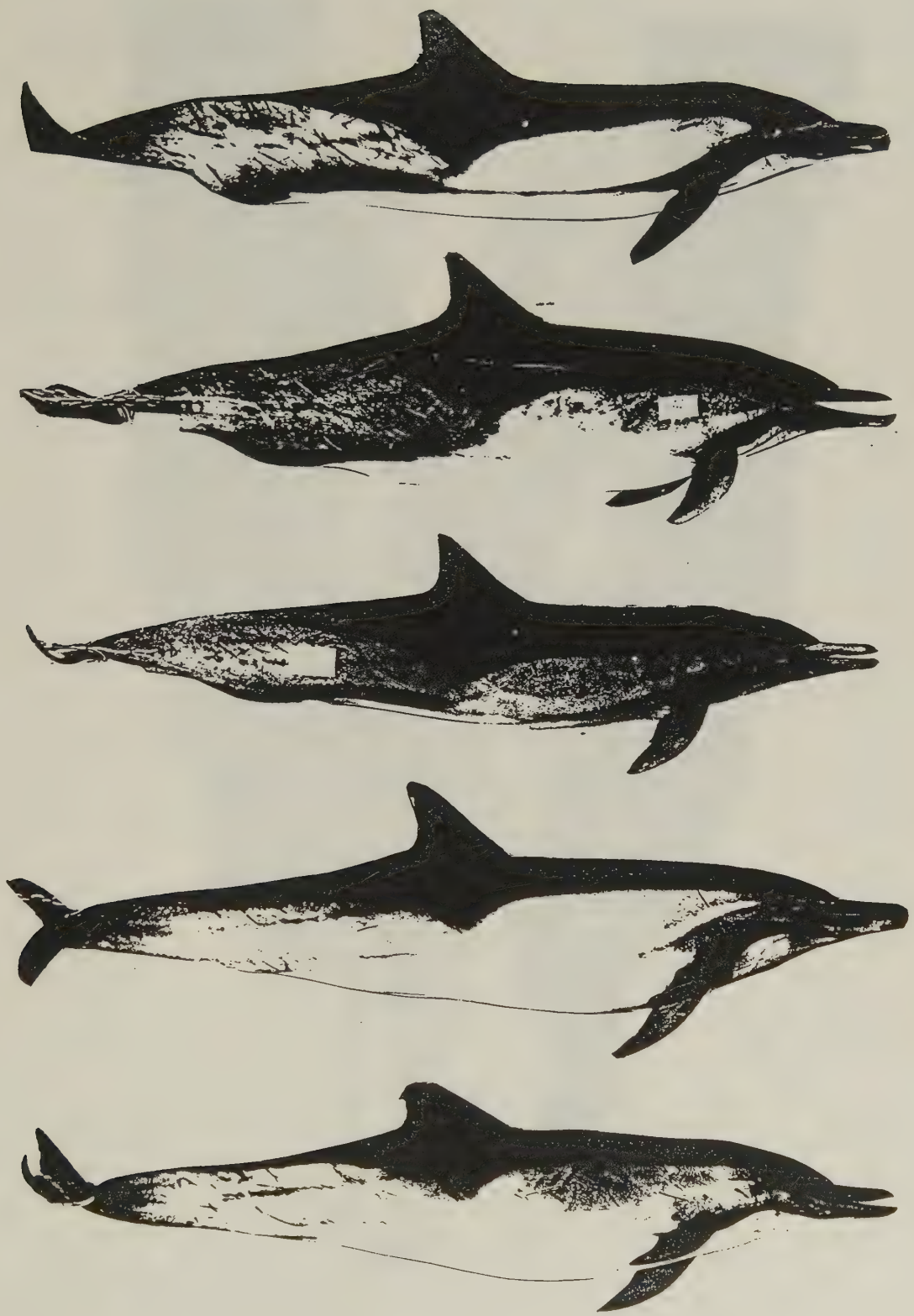


Figure 8

Figure 9

Figure 10

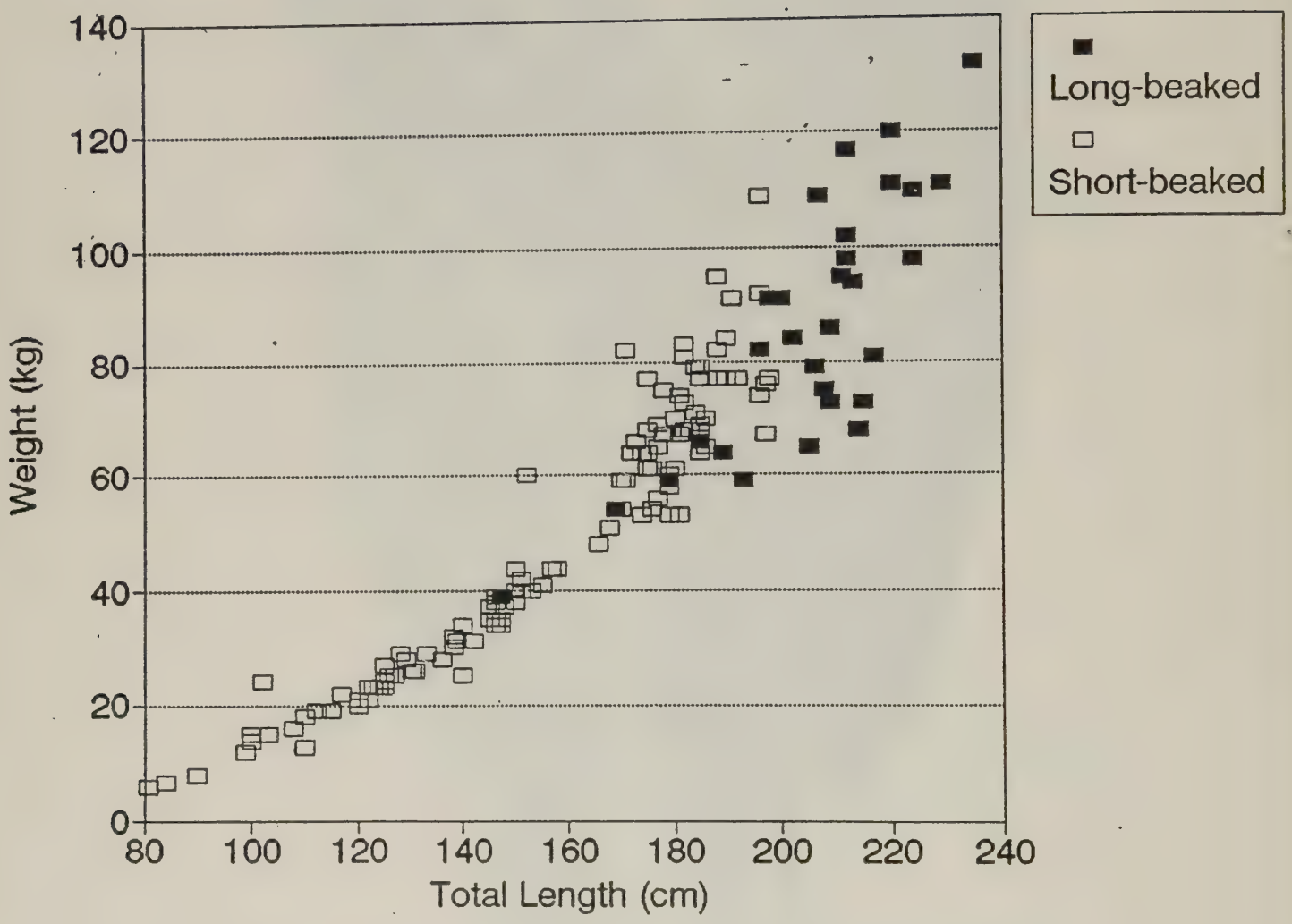

Weight (kg)
140
120
100
80
60
40
20
0
80
100
120
140
160
180
200
220
240
Total Length (cm)
Long-beaked
Short-beaked

Figure 11

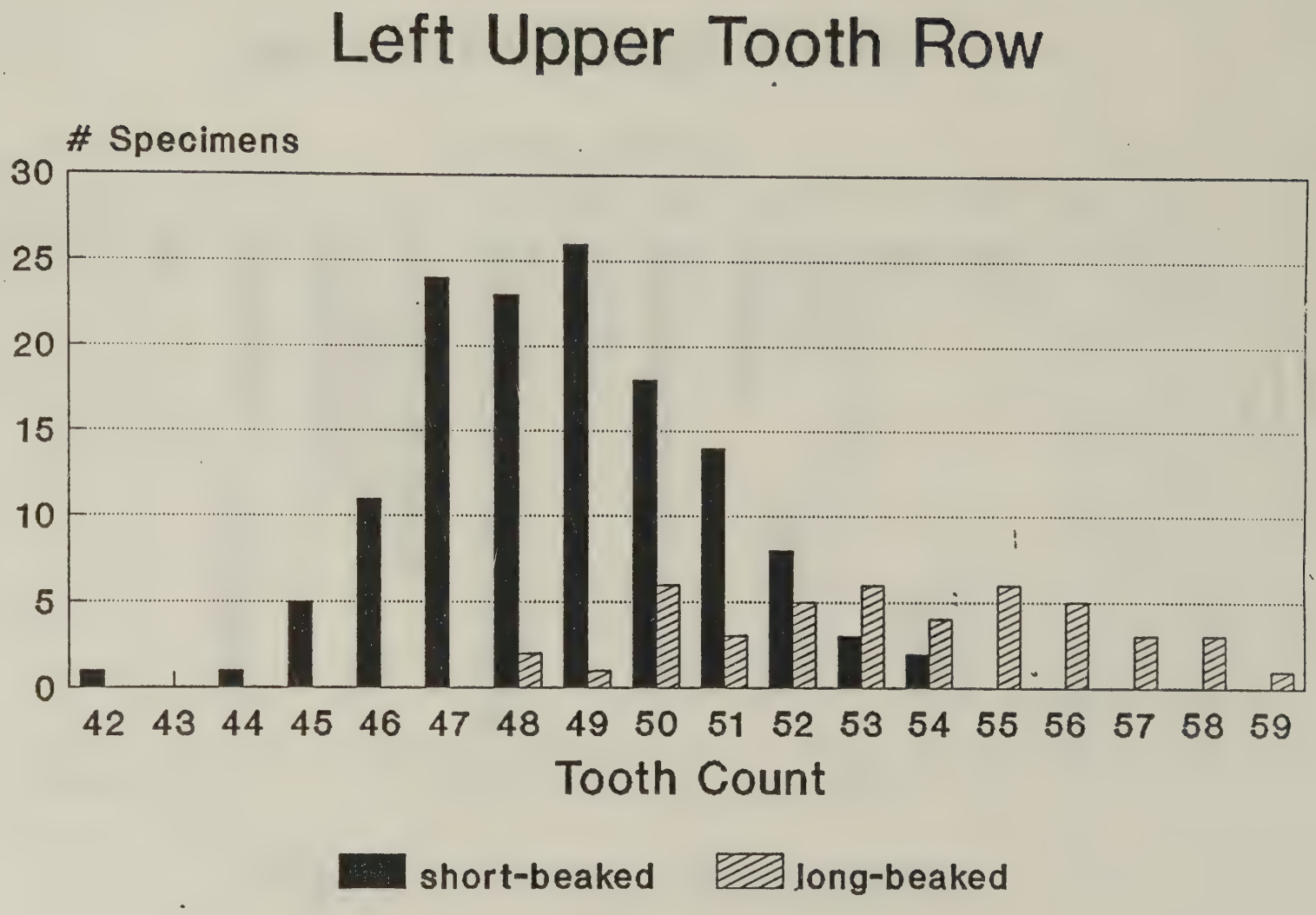

Left Upper Tooth Row
Specimens
30
25
20
15
10
5
0
42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
Tooth Count
short-beaked
long-beaked

Figure 12

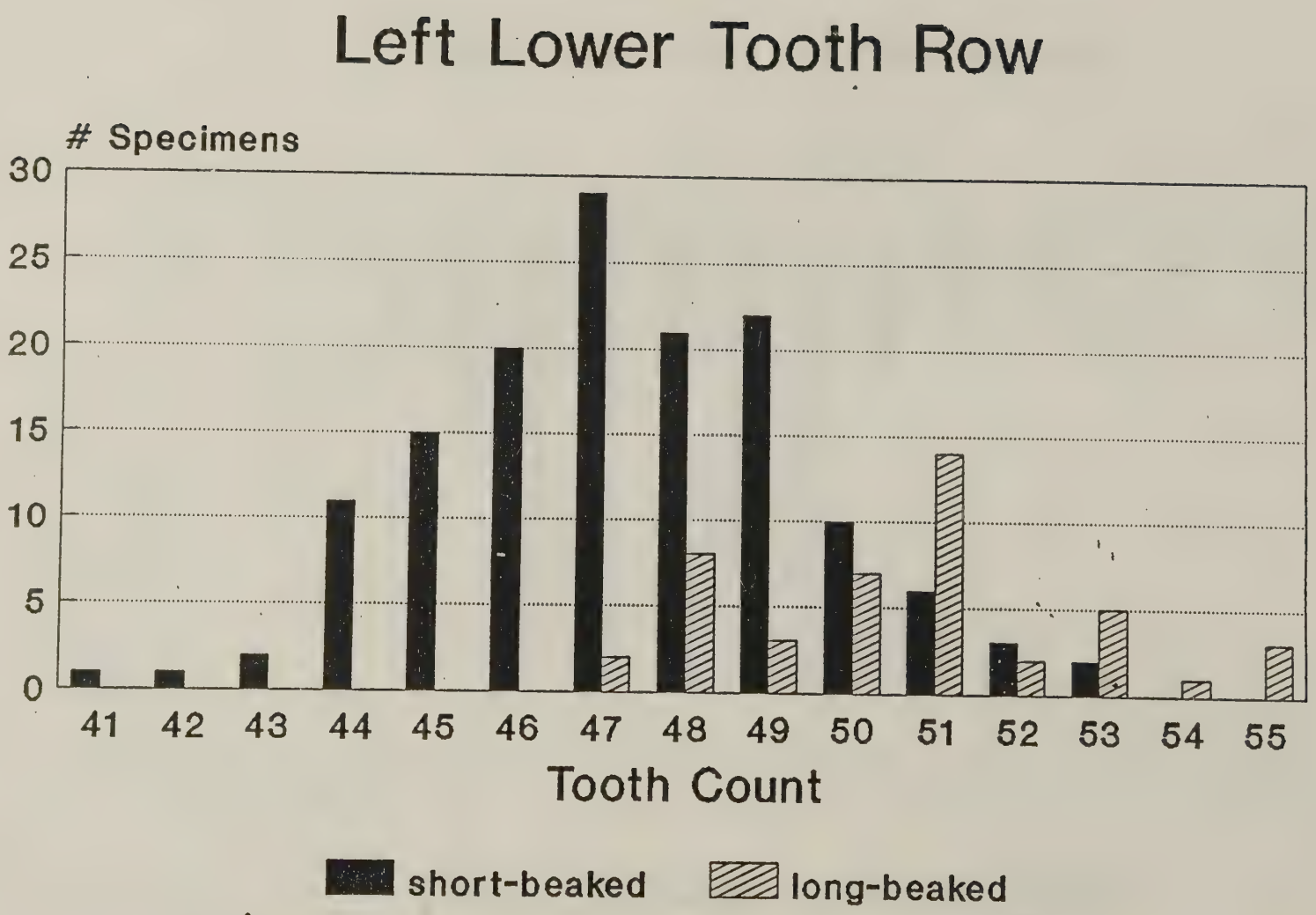
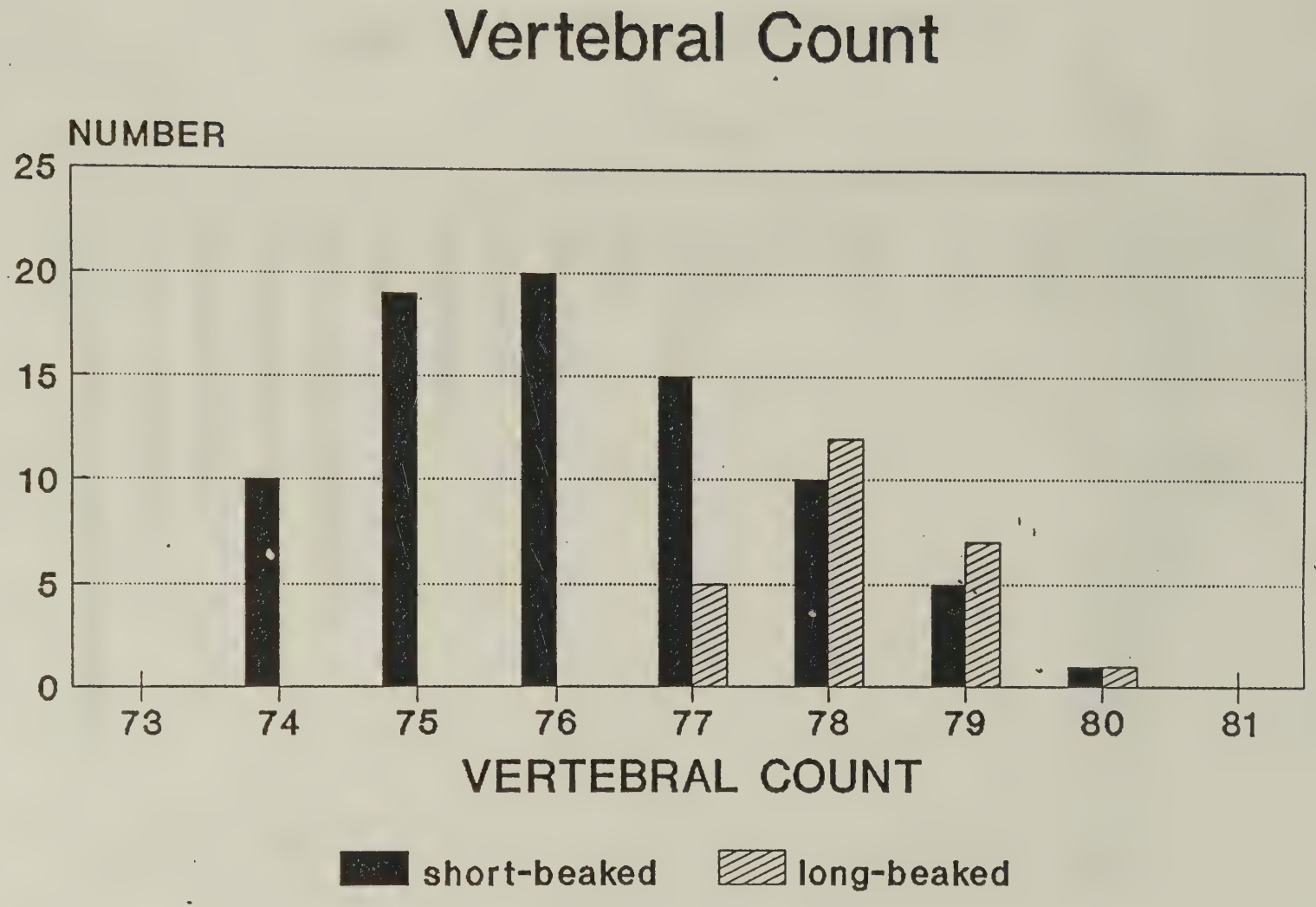

Left Lower Tooth Row
Specimens
30
25
20
15
10
5
0
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
Tooth Count
short-beaked
long-beaked

Figure 13


Vertebral Count
NUMBER
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20
15
10
5
0
73
74
75
76
77
78
79
80
81
VERTEBRAL COUNT
short-beaked
long-beaked

Figure 14

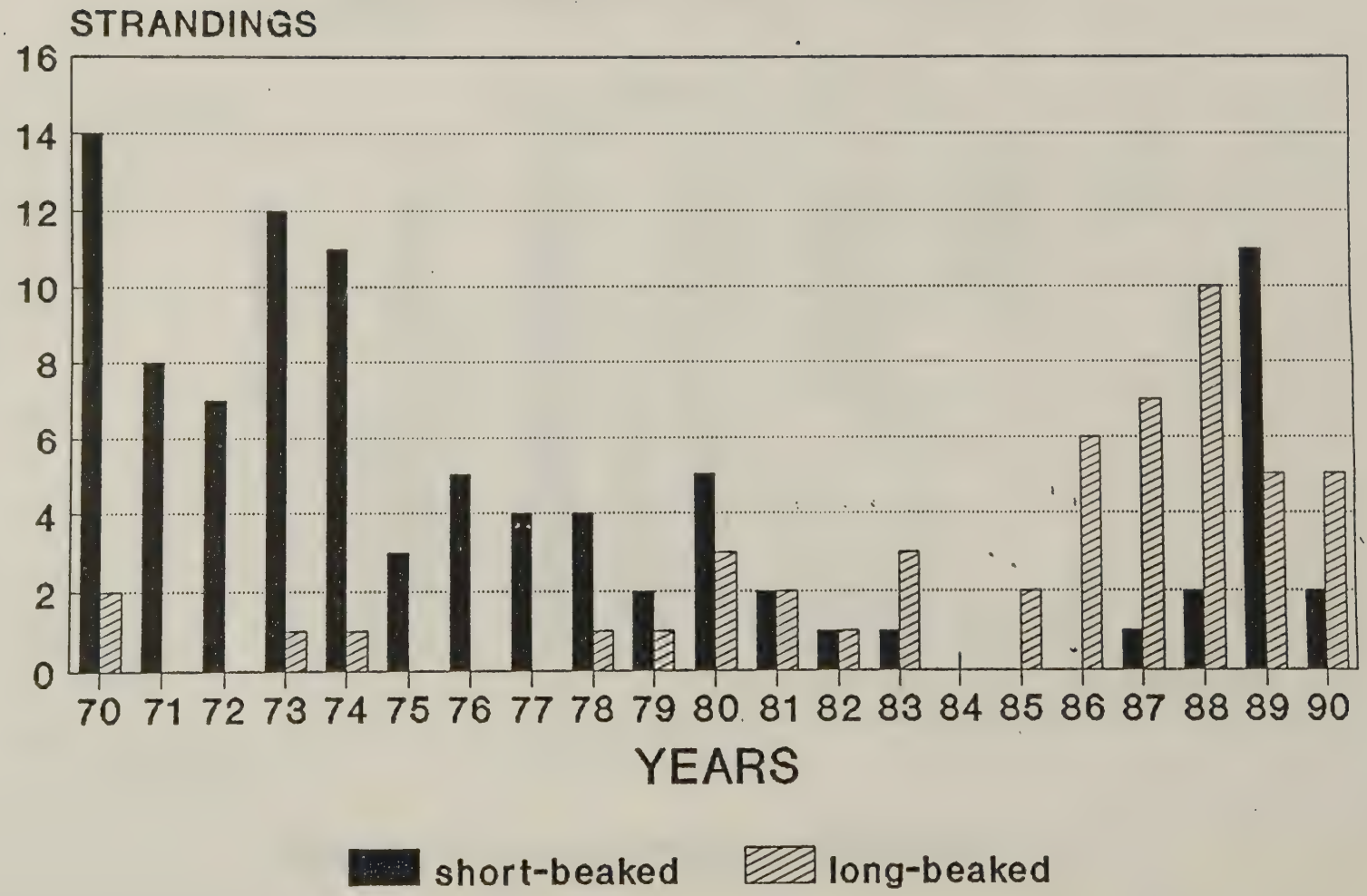
STRANDINGS
16
14
12
10
8
6
4
2
0
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90
YEARS
short-beaked
long-beaked

Figure 15

1

Figure 16